MARYLAND.

Agricultural Experiment Station.

BULLETIN NO. 23. of the Maryland Agricultural Experiment Station.

INJURIOUS INSECTS
OF
MARYLAND.

COLLEGE PARK, MD.

December, 1893.

MARYLAND

Agricultural Experiment Station.

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ADDRESS,
MARYLAND AGRICULTURAL EXPERIMENT STATION,
COLLEGE PARK, MARYLAND.

Bulletin of the Maryland Agricultural Experiment Station/

LETTER OF SUBMITTAL.

MARYLAND AGRICULTURAL EXPERIMENT STATION,
DEPARTMENT OF ZOOLOGY AND ECONOMIC ENTOMOLOGY,
COLLEGE PARK, MD.

DECEMBER 1ST, 1893.

SIR:

In accordance with your wishes, I take pleasure in submitting herewith a bulletin on some of the injurious insects of Maryland, with a treatment of the best methods of counteracting their injuries. It is my intention to follow this up from time to time with other bulletins of like nature, the particular subjects to be dealt with depending somewhat upon the inquiries received in the current correspondence of the Station, and upon the insect peculiarities of any particular year.

Respectfully yours,

C. V. RILEY.

Robert H. Miller, Esq.,

Director, Maryland Agricultural Experiment Station.

THE MARYLAND

AGRICULTURAL EXPERIMENT STATION.

Bulletin No. 23. December, 1893.

SOME INJURIOUS INSECTS OF MARYLAND.

BY C. V. RILEY, PH. D.

INTRODUCTION.

This is the first of a series of bulletins which I hope to issue from time to time upon the insects of Maryland. In my governmental work it is my object to avoid threshing over old straw and republishing anything that has been published before, as I conceive it to be the chief function of the Department of Agriculture and its various Divisions, to prosecute original research and to investigate those problems which yet remain to be solved. To a certain extent this I hope to do, as an officer of the Station, for the entomology of Maryland; but for the present I feel that it will be more productive of good to devote these bulletins primarily to those insects which are most important to the farmers and fruit growers of the State, by giving summaries of all the more important facts in reference to them, and dwelling more particularly on the methods of counteracting their injuries. The average farmer has little use for detailed descriptions of the forms of the minute life with which he has to deal, and for their recognition it will be better to depend upon good illustrations, with the barest indication of the colors and other salient characteristics. The figures in this bulletin, unless otherwise stated, are from my own drawings, or else from those made under my supervision.

THE CODLING MOTH.

(Carpocapsa pomonella L.)

LIFE HISTORY.

Wormy apples are fully as abundant in Maryland as in other states of the Union, and this worminess is due almost entirely to the larvæ of the Codling Moth. A little mass of brown excremental grains about the calyx end of the apple, or more rarely issuing from a small hole in its side, indicates the presence of this insect. Upon cutting the apple open these holes are seen to lead to rapidly broadening tunnels reaching to the core, which is often eaten through or surrounded by the nauseous brown cavities.

The perfect insect is, as shown at Fig. 1, a small grayish moth, which issues from its cocoon about the time the trees are in full bloom, and soon thereafter lays its eggs in the forming fruit, choosing the calyx cavity or its immediate vicinity for this purpose. The eggs hatch and the young larvæ gnaw their way through the skin and into the fruit, moving up and down freely in their burrows and enlarging the entrance holes to push out their excrement. In about a month they become full-grown. By this time the infested apples have begun to fall to the ground; but whether they fall or not, the larvæ bore to the sides and issue through a round hole. If issuing from a fallen apple, they crawl back to the tree trunk and mount it until some convenient crevice or piece of loose bark is found, and here they spin their cocoons and transform to the pupa state. If issuing from an apple which has not fallen, however, they crawl down the branches until they reach the rough bark of the trunk, on which, as in the other case, they spin their cocoons.

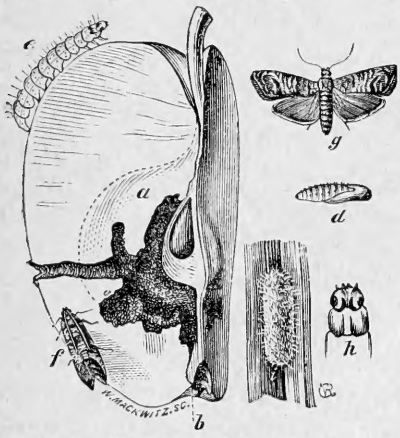


Fig. 1.—*Carpocapsa pomonella*; *a*, apple showing the work of the larva; *b*, point of entrance of the larva; *d*, pupa; *e*, larva; *f*, *g*, moth; *h*, head of larva; *i*, cocoon.

A few days after completing the cocoon, the larva in this first or summer generation changes to the chrysalis state, and in about two weeks, on the average, from the time of leaving the apple, issues as a moth. The female soon begins to oviposit, at this season not so uniformly in the calyx end as was the case with the preceding generation in the spring. This summer generation of moths issues quite irregularly, covering a

period of several weeks, and egg-laying thus extends into the late summer, so that larvæ of different sizes will be found in the apples during the late summer and autumn, and even well into the winter. The cocoons of these late individuals are usually spun in the crevices of the barrels in which the apples are packed for storage.

REMEDIAL MEASURES.

The damage which this insect wrought to the apple crop all over the country down to within the last eight or ten years was very great, and is still very serious in sections where intelligent measures are not taken to prevent it. Anywhere from 50 to 100 per cent. of wormy apples was common; and the effect of the alternate seasons of heavy and light setting of fruit was intensified to such a degree that in seasons of light setting, the crop was almost entirely destroyed.

In a few localities the old plan of bandaging or encircling the trunks of the trees with paper or rag bandages was systematically carried on, with the result of greatly reducing the proportion of wormy fruit, as the larvæ are very fond of spinning up in the shelter afforded by such bandages, and where these are systematically removed every two weeks and scalded, (or in the case of paper bandages burned) this method of checking the injury of the insect is well worth adopting. The efforts of the State Horticultural Societies of Michigan, Illinois and Kansas in the use of these bandages were particularly productive of good results, as there was co-operation. At the present time, however, this method has been almost entirely superseded by one which is, on the whole, better and simpler, viz: spraying with arsenical poisons. The use of arsenical poisons against this insect practically dates from 1878, though they had been employed on apple trees as early as 1872, against Canker Worms. It was in fact, their use against Canker Worms that led to the discovery that they were available as preventives of the Apple Worm. They are now very generally employed among the most advanced apple growers of the North and West, especially where a sufficient number of trees is grown to justify providing the proper machinery. This method is not confined to the United States, but has been introduced with profit into New Zealand, Australia and Tasmania, where the insect prevails as it does with us. Spraying with arsenicals was longer in making its way in Europe, but even in England and in parts of the continent apple growers are beginning to appreciate its value, though prejudiced against the use of poisons. Many of our apple growers, particularly in the South, have so far failed to appreciate its importance, and this is to a large extent true of the State of Maryland.

As some of our orchardists may yet fancy that the time and means required to spray effectively are wasted, let me quote a single instance of the value of spraying from a correspondent in the vicinity who is an extensive grower, and then give briefly some of the best and latest methods. Two years ago Mr. John S. Lupton of Winchester, Va., wrote me as follows:

"Please allow me to acknowledge my very great obligation to you for bringing to my attention, through your official publications, the use of arsenical poisons for destroying Codling Moth and other noxious insects.

"I have a fine young apple orchard of fifty acres, all Newtown Pippins, immediately adjoining which on the north is an older and much neglected orchard belonging to a neighbor.

"The old orchard has been badly infested with worms for many years, and until the present season the north half of my orchard has been practically worthless, the trees shedding most of their fruit in May and early part of June, the little which remained being so wormy as to be largely unfit for market, while the south half has borne fair crops, comparatively free from worms.

"Soil, drainage and other conditions being similar throughout, I am constrained to the belief that the near proximity of the old and worm-infested trees to the north side of my orchard is the cause of the difference above noted.

"Acting upon information obtained from one of your pamphlets, I bought last spring a full spraying outfit, using the Climax preparation of London purple sold by the Nixon Company.

"Soon after the blossoms fell I began spraying on the side nearest the old orchard, the machine working perfectly, the Climax nozzle breaking up the solution into a fine mist which completely enveloped the trees.

"After working a day and a half and applying the poison to about one-third of the trees, I suspended operations on account of the weather becoming so windy as to make the work exceedingly disagreeable, one of the men having been made sick by having the poison blown into his face.

"Influenced to some extent by the skepticism of my neighbors, most of whom regarded the experiment as highly dangerous, and confessing to no small lack of faith myself, I regret to say that I allowed other work on the farm to interfere, and never finished the work of spraying.

"With the mental reservation that should the heretofore barren north side where the poison had been applied do as well as the south half, I would spray more thoroughly next year, I waited the outcome with an indifference born of unbelief. Please note the result. From the sprayed trees, not quite one-third the whole number, I gathered 1,000 barrels of A 1 merchantable fruit so entirely free from worms that sorting was almost unnecessary, while the remaining two-thirds of the orchard yielded 883 barrels of good fruit, quite one-fifth of the apples on the unsprayed trees being wormy and unfit for sale. The market price of apples in this section the past season was from 60 to 75 cents per barrel, one or two choice lots of Ben Davis and York Imperial bringing $1 per barrel, while my fruit sold in the orchard nearly a month before picking at $2.55 per barrel.

"I estimate the cost of failure to spray the whole orchard at $2,500, but consider the lesson cheap at the price, as I shall never have it to learn again, and feel confident that with ordinary care no harmful results will follow spraying."

THE USE OF ARSENICAL SPRAYS.

Substances to be used.—Two arsenical poisons are commonly used in spraying orchard trees for the Codling Moth, namely, Paris green and London purple. Of the two, Paris green still holds the vantage ground by virtue of the fact that it is insoluble in cold water and contains a more constant proportion of arsenic. London purple, on the other hand, is somewhat cheaper, and the slightly purplish hue which it imparts to the treated foliage possesses some value as indicating more clearly the efficacy of the spraying, for it permits us to see whether or not the application has been uniformly made and has taken a firm and uniform place upon the leaves, which the Paris green does not show to the same extent. The slight solubility of the purple in cold water renders it more apt to

burn the foliage, but this difficulty is easily overcome by the addition of a small quantity of lime water to the mixture, thus transforming the soluble arsenic into insoluble calcic arsenite.

The use of ordinary white arsenic is not advised because of its insolubility and its color, which renders it indistinguishable from some harmless substances for which it is apt to be mistaken, so that it is more dangerous to have about the farm in quantities.

Either London purple or Paris green, then, should be thoroughly mixed with water in the proportion of one pound of the poison to 150 gallons of water, and this mixture should be thrown in a fine spray through the trees, so as to thoroughly moisten all parts of the leaves and fruit. I cannot too strongly urge the advantage of careful spraying which shall cause a uniform fall in the form of a mist, and not drench the tree, and thus cause the concentration of the poison in particular spots. The spray should be forced from the center of the tree and then all around it, in an even mist, which will settle uniformly on all parts. The first application should be made about a week after the blossoms fall and before any of the larvæ have hatched or entered the fruit, as the efficacy of the spraying depends upon the larvæ taking a small quantity of the poison with their first meal in eating through the calyx of the young apple. Unless a heavy fall of rain should follow this first application, the spraying will not have to be repeated. A small quantity of flour or starch mixed in at the time of stirring the poison in the water will tend to make the spray adhere better and more uniformly, but these sticky substances should not be mixed with London purple as they precipitate the poison and rather increase the inequality of its distribution.

One great advantage of such spraying is that in addition to greatly lessening, if not practically checking, the work of the Codling Moth, it also destroys a great number of insects which feed upon the leaves of the apple tree, and in a measure will also serve as a protection against certain fungus diseases. Where orchards are seriously affected with rust or scab, it is desirable even to combine with the arsenical spray a certain amount of Bordeaux mixture, and a good formula for this last is, 7 pounds of unslaked lime, 6 pounds of copper sulphate (or blue stone), ½ pound of London purple, and 75 gallons of water.

Apparatus for Spraying.—For orchard use, the knapsack pumps or bucket pumps are practically unavailable, however useful for a few trees by means of ladders. I shall therefore not consider them in this connection, but refer to a few of the more important tank or barrel pumps and state the requisites of a good orchard spraying apparatus.

The following firms manufacture spray pumps of several styles and are always glad to send circulars to fruit growers:

Nixon Nozzle & Machine Co., Dayton, Ohio.
Field Force Pump Co., Lockport, N. Y.
Deming Manufacturing Co., Salem, Ohio.
W. & B. Douglass, Middletown, Conn.
The Gould's Company, Seneca Falls, N. Y.

A good, strong double-acting force pump should be purchased and mounted on a large stout barrel with the supply tube reaching well down to the bottom. It has become the custom to mount the pump in the end of the barrel, but except in the case of the Nixon Tripod, it will be almost as easy to mount it on the side of the barrel, which is easily held in place by a skid near either end, and is then more compact and stable than when standing on the end, while the handle of the pump comes lower and is more easily worked.

It will be well to buy the pump without attachments. About 25 feet of ¼ inch cloth insertion rubber tubing is attached to the discharge orifice, or to each of the orifices in case there are two. To the end of the tube is fitted one of the modifications of the Cyclone or Riley nozzle and the outer 8 or 10 feet are clamped or wired to a light pole or bamboo fishing rod for convenience in elevating the nozzle into the larger trees. The tank or barrel is mounted on a cart or sled and driven between the tree rows, one man driving and pumping and the other holding and directing the extension pole and nozzle.

I have mentioned the cyclone nozzle for the reason that, all things considered, I believe it, in some of its modifications, to be the best for orchard work. The Climax nozzle manufactured and sold by the Nixon Nozzle & Machine Co. is also a good nozzle, but it is rather large and clumsy, its spray hardly so fine, and it will not answer for fungicides containing lime, since it clogs easily. The Vermorel modification of the Cyclone nozzle (Fig. 2) possesses a little attachment which quickly unclogs the orifice when once stopped up, and is therefore preferable. Moreover, neither the Cyclone nor the Vermorel modification is patented, which, other things being equal, is in their favor. Both are manufactured by Thomas Somerville & Sons, Washington, D. C., and Robert Leitch & Sons, also of Washington, or may be made by any brass and iron worker from the descriptions in my official reports* or from the accompanying figures.

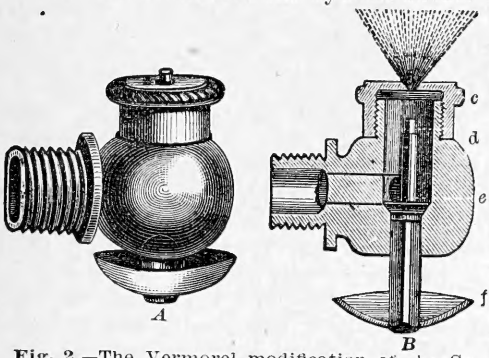


Fig. 2 —The Vermorel modification of the Cyclone Nozzle—natural size (Original).

A, entire; *B*, in section; *c*, removable cap; *d*, end of cleaning rod; *e*, rubber casket to prevent backward escape of liquid; *f*, cap to hold liquid when cleaning rod is pushed forward.

NATURAL ENEMIES.

While ordinarily little can be done to encourage the natural enemies of the Codling Moth, there are nevertheless a few which it is well worth while for the orchardist to become familiar with. Those of its own class which he will most often meet with in sheltered situations, about the trees or under the bandages used to trap the worms are the following:

*INSECT LIFE, Vol. I. p 243-244; Fifth Report U. S. Entomological Commission, p 45.

THE PENNSYLVANIA SOLDIER BEETLE.—(*Chauliognathus pennsylvanicus* De Geer.) This is a little yellowish beetle (Fig. 3, *i*,) with more or less black upon its wing-covers and upon the thorax, abundant on almost all pollen-bearing flowers; but while the beetle is pollinivorous, the larva is carnivorous and devours the apple worm either within the apple or while it is getting ready to spin up. The accompanying figure (3) shows this insect in the larva state at *a* and the adult at *i*, the other figures indicating details of the larval structure.

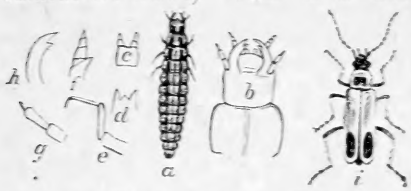


Fig 3.—*Chauliognathus pennsylvanicus*: *a*, larva, natural size; *b*, head and first segment of same (enlarged); *c*, labium; *d*, labrum; *e*, leg; *f*, left maxilla; *g*, antenna; *h*, left mandible; *i* imago.

THE TWO-LINED SOLDIER BEETLE.—This is an allied species belonging to another genus and known entomologically as *Telephorus bilineatus* Say. Here also it is the larva which preys upon the apple worm. Figure 4, shows it in natural size at *a*, its head and two thoracic segments at *b*, enlarged, and the beetle natural size at *c*. The larva, like the preceding, is of a rich, velvety-brown and black color, the beetle having brown and black wing covers and reddish-yellow thorax, the latter having two short black longitudinal marks, from which the insect takes its name.

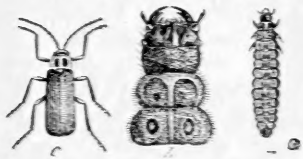


Fig. 4.—*Telephorus bilineatus*: *a*, larva, *b*, anterior joints of same (enlarged); *c*, imago.

In the Fourth Report on the Insects of Missouri, 1871, I called attention to the fact that the principal bird enemies of the Codling Moth are the Creepers, Black-capped Titmouse, the Downy Woodpecker, the Blue Bird and the Crow Black Bird. In the Fifth Report of the same series I described and figured two true parasites. The Ring-legged Pimpla (*Pimpla annulipes*, Br.,) and the Delicate Long Sting, (*Macrocentrus delicatus* Cress.,) and there mentioned the fact that a species of Hair-snake or Hair-worm, (*Mermis acuminata*), also infests the larva. All of these insects are found in Maryland. I have also found a peculiar larva of another Beetle, (*Tenebrioides corticalis*, Fig 5), preying upon the larvæ, while Dr. LeBaron, (Fourth Report as Illinois State Entomologist, p. 64), records the same habit of the same species and Mr. C. D. Zimmermann records a similar habit, on the part of the larva of *T. laticollis*, (*Canadian Entomologist*, 1878, p. 60). In Europe three

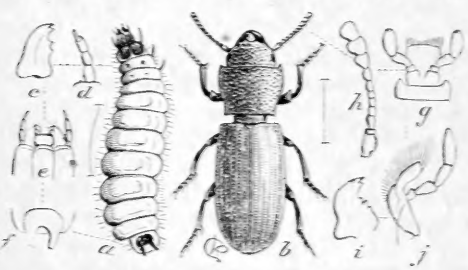


Fig. 5.—*Tenebrioides corticalis*: *a*, larva; *c*, its mandible; *d*, antenna; *e*, under side of head; *f*, the two-horned anal plate; *b*, the beetle; *h*, its antenna; *i*, mandible; *g*, labium and its palpi; *j*, one of the maxilla and its palpus.

Ichneumon flies prey upon the Codling Moth. These are *Phygadeuon brevis*, *Pachymerus vulnerator* and *Campoplex pomorum* Rtz. On the Pacific Coast the Ring-legged Pimpla, (*Pimpla annulipes* Br.,) is an important parasite of the Codling Moth, as ascertained by Mr. Albert Koebele who has also found several new enemies of this insect there. Two Dermestic beetles also feed upon the pupa in California. These are *Trogoderma tarsale* and *Perimegatoma variegatum* as shown in my Annual Report as U. S. Entomologist, for 1887. Mr. Koebele has also found a species of the Chalcidid genus Trichogramma, which infests the eggs of the Codling Moth and has further observed that the larva of a species of the very peculiar Neuropterous genus Rhaphidia runs up and down the tree trunks, searching for Codling Moth larvæ and pupæ (see Bulletin 22, Division of Entomology, U. S. Department of Agriculture, pp. 90-92). Mr. Koebele has also reared a parasite of the genus Pteromalus, but this may be a secondary parasite on the Pimpla above mentioned or upon one of two other primary parasites of the genera Cryptus and Phygadeuon which he has also reared from Codling Moth cocoons.

Some of these California insects were sent by me through Mr. Koebele to New Zealand and Australia, for the purpose of introducing them into the apple orchards of those countries, and they as well as the European parasites, are mentioned in this connection, as it may be desirable in special cases to introduce them into apple orchards in the eastern United States.

THE GREEN JUNE BEETLE.

(Allorhina nitida L.)

This is an insect which has become more and more noticeable during recent years and has at times proved exceedingly destructive, especially to lawns in the vicinity of Washington. It is very common in Maryland, where it is known ordinarily as the June Beetle or the June Bug, a term which has, however, been very loosely applied to several insects and particularly to the common May Beetle (*Lachnosterna fusca*). These May Beetles, or June Bugs as they are called in the northern states, of the genus Lachnosterna, are brown beetles which begin to fly in the month of May, though they continue into June and even later, in the latitude of Washington. Under the circumstances it will be well to designate the insect I am now treating by the name indicated in the title. The larvæ of this insect and those of the May Beetles, have a similar general appearance and are known popularly among farmers by the rather comprehensive name of White Grubs. The larvæ of the true May Beetles are, as a rule, smooth and naked in appearance, though when examined under a strong lens, minute stiff hairs or bristles may be found on different portions of the body. But the larva of our Green June Beetle is clothed with minute yellowish hairs in sufficient numbers to make them easily observable with the naked eye. The two kinds of White Grubs may be further distinguished by the fact that when the larva of Allorhina is placed on a smooth surface it will immediately turn over on its back and rapidly move away by the alternate expansion and contraction of the body seg-

ments, while the White Grubs proper, the larvæ of Lachnosterna, will lie in a half-coil on their sides, or make awkward efforts to use their feet, being essentially burrowers. It is for these reasons that I have figured the larva of Allorhina on its back, as shown in the accompanying illustration, (Figure 6).

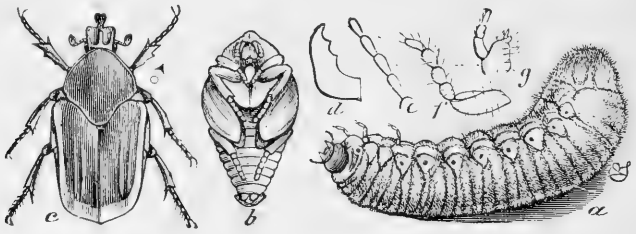


Fig. 6.—*Allorhina nitida;* *a*, larva; *b*, pupa, *c*, imago; *d*, *g*, mouthparts of larva; *d*, mandible; *e*, antenna; *f*, maxillary palpus; *g*, maxilla.

The larvæ of the Green June Beetle attract more attention than the others, partly because they are somewhat larger in size, and partly because they occur abundantly every year and are more easily brought by disturbances and by irrigation to the surface of the ground. The parent beetles begin to fly the latter part of June, increase somewhat in numbers during July and August, and disappear in September. Like the other species of its sub-family this Green June Bug does not devour the leaves, like the true May Beetles, but feeds upon over-ripe fruit and vegetables. It is fond of clustering in numbers upon anything that is over-ripe or half decayed, especially half decayed melons, and does in this way more or less damage to ripe peaches hanging on the tree. It will swarm around the flowing sap of fruit trees or even of young oaks and maples, wherever there is a braise inducing such flow, and I have noticed that they are particularly fond of feeding at the moisture that frequently results from the attacks of borers. A closely allied species, *Euryomia melancholica* is commonly known as the Fig-eater from its similar habit of attacking fully ripe or over-ripe figs. Nevertheless the damage which the parent beetle does is slight compared with the injury which the species often does in the larva state.

Although so common, the readers of this bulletin will be surprised to learn that there is a great deal yet to learn in reference to it, and that its full life-history has not been traced. This is largely due to the fact that the larva works under ground and out of sight, and to the further fact that it is somewhat difficult to rear in confinement. I received two specimens of this larva in November, 1868, from Mr. G. D. Baker, of South Pass, Ills., who found them in his strawberry beds in company with one of the May Beetle larvæ, and it was at once noticeable that this Green June Bug differed from all I had up to that time studied in its peculiar habit of crawling on its back, traveling with the same motion and quite as rapidly as an ordinary caterpillar, and invariably turning on its back to move or to burrow. These larvæ remained alive in-doors, feeding greed-

ily on roots of wheat which I grew for them. In April, 1869, they formed tough, hard cells of earth, and by the middle of May had changed to pupae (Figure 6, *b*), the adult beetles issuing in June.

Around Washington these larvæ are observed almost every autumn, and are not infrequently brought to me by persons who find them crawling in large numbers on the ground. This is particularly the case on the sidewalks adjoining the lawns of the Capitol grounds, where they are sometimes so numerous that bushels of them may be swept together.

The beetles lay their eggs, unquestionably, underground, and though the egg has not yet been observed or described, there is no question in my own mind that the beetles are attracted to any soil which is heavily mulched and where there is manure or decomposing vegetation. I have seen them swarming and buzzing lazily over the ground on the New Jersey coast wherever the sand was covered with sea-weed or marsh grass, settling down every once in a while to enter the ground or get beneath the mulching. There is every reason to believe from the size of the larva and the habits of the beetles, that the eggs are laid during any of the summer months, and even during September. The early life-history of the larva has not been studied, but it is well-known that as it attains full growth it injures the roots of vegetation. Yet my own impression is that during most of their growth these larvæ are comparatively harmless, feeding largely on vegetable humus and deriving the greater part of their nourishment in this way. The contents of the very large alimentary canal in color and consistence, would indicate this habit.

The exact length of the insect's life in the larva state is also not accurately known, and this is one of the points which is now being investigated at the Station. In late autumn two distinct sizes are noticeable, though larvæ of almost every size may be found. The prevalence of these two sizes would indicate that the larva requires perhaps two years for full development, yet I am more inclined to attribute the difference in size to differences in the period of egg-laying and hatching and to believe that the insect may go through all its transformations in a single year.

It will thus be seen that there are many points yet to be ascertained in the life-history of this insect, common as it is, and that some of these, when ascertained, may give us a clue to a better management of it.

REMEDIES AND PREVENTIVES.

Undoubtedly one of the best available remedies which we have, and one which is by no means extravagant in cost in a strawberry bed where plenty of water is convenient, is the application of a dilute kerosene emulsion. The experiments which I had tried a few years ago on the lawn in front of the east wing of the Capitol at Washington, (see *Insect Life*, Vol. I., No. 2, pages 48-50, Aug., 1888), showed that one part of the standard kerosene emulsion diluted with fifteen parts of water, and subsequently well washed down into the soil by copious applications of water, will kill all the grubs which it touches, and at the same time will penetrate sufficiently deep into the ground to reach those grubs which are furthest down. Moreover it is found that even at a strength of one part of the emulsion to eight parts of water, the grass is not injured. In addition to

this it was found that heavy watering will cause these grubs to rise to the surface of the ground. We have, then, simply to pour an abundance of water upon the affected soil and when the grubs begin to appear upon the surface of the ground, to treat them thoroughly with the emulsion at one part to fifteen of water. Then, after say twenty-four hours, pour on more water to carry the insecticide further down into the soil. The economy of this plan may be shown by the following facts: One barrel of kerosene costing $4.50, and a sufficient quantity of soap to make half a barrel of strong soapsuds, costing, say, twenty-five cents, will make a barrel and a-half of standard emulsion or twenty-two and-a-half barrels of the dilute emulsion. This will be amply sufficient to treat an acre of strawberries and even more upon a porous soil. Upon large field crops this process would prove too expensive, but as a matter of fact, this insect is always most abundant upon small, choice, heavily manured or mulched crops, and there is seldom any occasion for treating field crops.

A most interesting case was reported to me the present season by Col. Wright Rives, of Rives Station, Md., near the College. An acre of choice celery upon his place was found to be fairly teeming with these grubs. They did not seem to injure the celery by attacking the roots, but damaged it by carrying dirt into the heart and inducing rot by contact with their acid excrement. Upon investigation I felt quite certain that the heavy mulching and large masses of rotting straw which had been accumulated in the neighborhood, had served to attract the parent beetles, and thus induce their concentration upon the celery beds. The experiments which Mr. Lull has recently made upon Col. Rives' place prove that the application of the standard kerosene emulsion, as above recommended, or at the rate of one part to fifteen of water, does not injure the celery in the slightest, while it kills the larvæ when they are at or near the surface of the ground. Experience this autumn with these larvæ shows that in addition to the food-habits already indicated, they are, on occasions, quite inclined to be carnivorous, so that when several are placed together in a breeding-cage or jar they invariably feed to some extent upon each other.

As this larva has not yet been fully described, I close this article with a technical description, which will have some entomological value, though descriptions of these Lamellicorn larvæ are necessarily unsatisfactory except by comparison with other allied forms.

Allorhina nitida.—Full grown larva.—Length, 40 millimetres, somewhat largest posteriorly, sub-cylindrical, broader at thorax and eighth and ninth abdominal segments, which are materially swollen. More flattened ventrally, with a distinct swollen lateral ridge just below the stigmata, which rather increases the flattened aspect of the venter. General color, glassy yellowish white, inclining to green or blue towards the extremity. Head, rather small, flattened, well inserted into the prothoracic segment, chestnut brown in color. Dorsal surface of the body strongly transversely corrugate or wrinkled, each of the chief segments having three distinct ridges, the whole body studded with short, thick yellowish bristles, which are most dense on the dorsal ridges and

more sparse, but longer, on the ventral and anal segments. Dorsally these stiff hairs are directed posteriorly and materially assist in the dorsal locomotion. The legs are honey yellow, covered with similar stiff bristles without definite tarsal claw. They are short, compared with the larvæ of Lachnosterna, generally. Prothoracic segment with a honey yellow horny plate in front of the spiracle, which, as usual, is rather larger than the abdominal spiracles. Mandibles short, stout, dark brown, with the left (looking from the dorsum), 4–dentate and the right, 3–dentate. Antennæ short, 4–jointed, joints sub-equal in length, diminishing in width, from 1 to 4, maxillary palpi, 3–jointed, joints sub-equal in length, terminal narrowest at tip. Labial palpi, 2–jointed, joint 1 longest, somewhat swollen at tip and bearing a short pointed joint 2, on the inner side of its tip. Labium covered with short stout bristles. Maxillæ with long, stiff bristles on the inner surface and with two long, sharp, black teeth near the tip.

The half-grown larva does not differ in structure or coloration.

CABBAGE WORMS.

Six different species of caterpillars or worms, affect the Cabbage very commonly, in the state of Maryland. All feed upon the outer leaves, often boring well into the head. They are known by the following names: The Imported Cabbage-worm (larva of *Pieris rapæ* L.), the Cabbage Plusia, (*Plusia brassicæ* Riley), the Cabbage Mamestra, (*Mamestra trifolii* Rott.), the Zebra Caterpillar, (larva of *Mamestra picta* Harr.), the Cabbage Evergestis, (*Evergestis rimosalis* Gn.), and the Cabbage Plutella or Diamond-back Moth, (*Plutella cruciferarum* L.). All of the insects will be found treated at some length in my annual report, as Entomologist to the U. S. Department of Agriculture, for 1883, to which I would refer those who care to go into the details of the subject. For the purpose of this bulletin, it is my desire to dwell principally on the facts of practical value.

Fig. 7.—*Pieris rapæ*; *a*, larva; *b*, chrysalis,

The Imported Cabbage Worm (*Pieris rapæ*), is a pale green caterpillar, about 32mm. (one and a quarter inch) long when full-grown, (Fig. 7, *a*). It is very finely dotted with black, has a faint yellowish line down its back and a row of yellow dots along each side. It

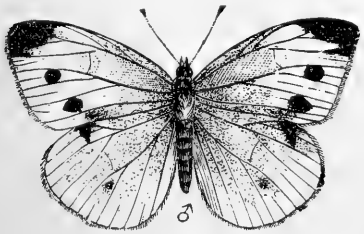


Fig. 8.—*Pieris rapæ*, male

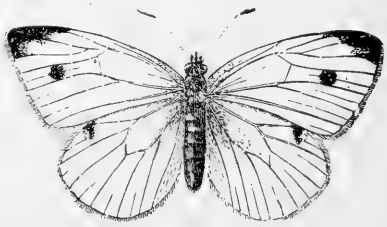


Fig. 9.—*Pieris rapæ*, female.

hatches from a minute yellowish, ribbed egg and transforms to a pale green chrysalis, covered with small black dots, (Fig. 7, *b*). The adult butterfly is the common white or yellowish white species, with black spots, as at Figures 8 and 9, seen flying about cabbage patches.

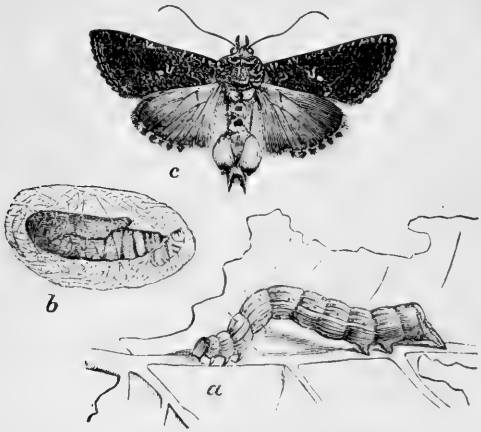


Fig. 10—*Plusia brassicæ*; *a*, caterpillar; *b*, chrysalis in cocoon; *c*, moth, male.

THE CABBAGE PLUSIA (*Plusia brassicæ*) is also a green caterpillar but is larger than the preceding and lighter in color. It is marked with lighter longitudinal stripes and is very soft bodied and tender. It measures 2 inches in length when full-grown, (Fig. 10, *a*.)

The egg from which it hatches is pale greenish yellow in color, convex in shape and two-hundredths of an inch in diameter. In transforming to pupa the caterpillar spins a delicate semi-transparent web usually partly or entirely wrapping itself in a leaf, (Fig. 10, *b*.) The adult insect is a dark gray moth with a wing spread of about 1½ inches and marked with a bright silvery dot and V-shaped mark near the center of each front wing, (Fig. 10, *c*.)

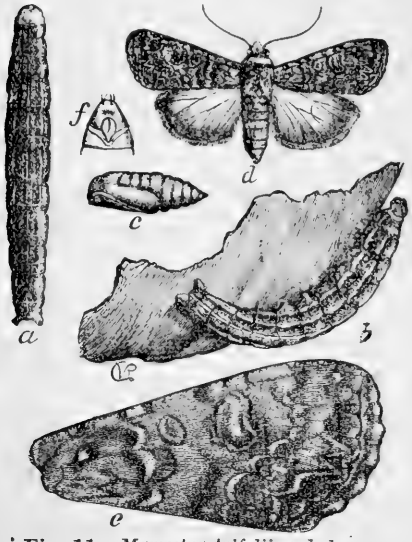


Fig. 11.—*Mamestra trifolii*; *a*, *b*, larvæ; *c*, pupa; *d*, moth; *e*, wing of same (enlarged); *f*, anal segment of pupa.

THE CABBAGE MAMESTRA (*Mamestra trifolii*) is a variable caterpillar in color, some being bright green above and some nearly brown, but all are marked by a rather broad pink stripe down each side, (Fig. 11, *b*. *c*.) It transforms to pupa in an oval cavity about two inches below the surface of the ground. The parent moth is somewhat variable in size and color, ranging from a pale yellowish-gray to a dark brownish-gray but mottled as in the figure, (Fig. 11, *a*. *d*.) It is readily distinguished from the moth of the Plusia by lacking the silvery spot on the front wing. This insect is more common in Maryland cabbage-fields than I have known it elsewhere.

THE ZEBRA CATERPILLAR (larva of *Mamestra picta*) is a very easily distinguished insect. When first hatched it is almost black but soon becomes pale and green. When full-grown it is 2 inches long, velvety black, with tawny red head, legs and belly and two narrow yellow lines along the side between which are many white irregular zebra-like finer lines. The pupa is found, like that of the preceding species, beneath the surface of the ground. The front wings of the adult moth are rich purple-brown and the hind wings are white, faintly edged with brown, (Fig. 12).

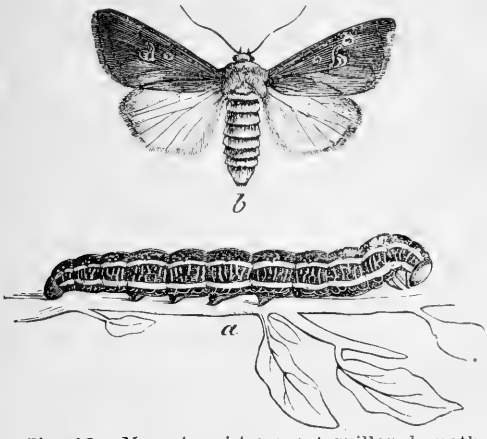


Fig. 12.—*Mamestra picta; a*, caterpillar; *b*, moth.

THE CABBAGE EVERGESTIS OR CABBAGE PIONEA as it used to be called (*Evergestis rimosalis*) is a small purplish-brown or bluish-brown worm with a greenish-yellow head and green venter. When full-grown it is a little over half an inch in length and transforms to pupa at the surface of the ground in a slight oval cocoon covered with earth. The moth is pale ochre-yellow in color, the front wings darkening towards the tip, with the hind wings semi-transparent near base, (Fig. 13, *c*). It has a wing spread of about 1 inch. This caterpillar is rather fond of boring into the cabbage heads which renders it more destructive and harder to treat than if it confined itself to the outside leaves.

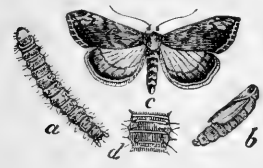


Fig. 13.—*Evergestis rimosalis; a*, larva; *b*, pupa; *c*, moth; *d*, segment of larva (enlarged).

THE CABBAGE PLUTELLA (*Plutella cruciferarum*) is a little, active pale green worm, something over a quarter of an inch in length. It pupates within a delicate gauze-like cocoon resembling lace. The parent moth has narrow wings—expanding five-eighths of an inch, and is of an ash-gray color, usually with an undulate pale streak along the inner border of the front wings, (Fig. 14. *f*. *g*.), which gives a series of diamond-shaped marks when the wings

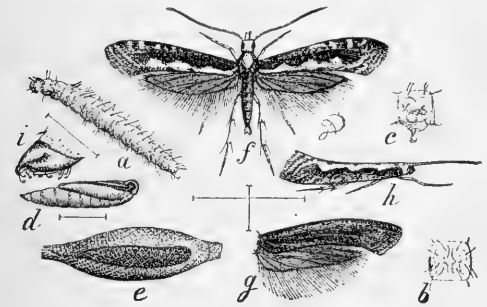


Fig. 14.—*Plutella cruciferarum; a*, larva (enlarged); *b*, dorsum of a single joint (greatly enlarged); *c*, side view of same; *d*, pupa (enlarged); *e*, cocoon (enlarged); *f*, moth (enlarged); *g*, wing of dark variety (enlarged); *h*, moth at rest (enlarged); *i*, cremaster of pupa (greatly enlarged).

are closed. This worm feeds only on the outer leaves of the cabbage.

REMEDIES FOR CABBAGE WORMS.

All of the above-mentioned cabbage worms are amenable to about the same treatment. In my 1883 Report, already referred to, I recommend hot water (at a temperature of about 130° F.), pyrethrum powder, 200 grains to 2 gallons of water, and kerosene emulsion. I also mentioned the fact that dry applications of lime, salt, pepper, bran, buckwheat flour, road-dust, soot, or of any other fine powder are efficacious against the *young* worms and quoted Mr. P. T. Quinn's remedy of sawdust, impregnated with carbolic acid as well as an anonymous remedy from the *N. Y. Tribune* of 20 parts superphosphate of lime, 3 parts shell or fresh air-slaked lime and 1 part of carbolic powder. I also mentioned the fact of the efficacy of the arsenical poisons, but stated that few persons would use them for fear of their poisonous effects.

Since that time little has been suggested that is new, but many experiments have been made with the remedies mentioned above. Prof. Lawrence Bruner of Nebraska claims that corn meal dusted on the cabbages causes the worms to fall off and protects the crop until washed off by rain. It should be applied in the morning while the dew is on.

The best results, however have been reached by a careful, intelligent and sparing use of Paris green and London purple. Many successful cabbage growers are today using these poisons. I am very loath to recommend them, for there is danger unless the greatest care be had. When Paris green is thoroughly and evenly mixed with flour at the rate of one ounce of the green to 100 ounces of flour and dusted through a cloth bag so as to just make a slight show of dust upon the leaves, the worms will all be killed in the course of 2 or 3 days. Prof. C. P. Gillette has shown that, applied in this way, the average amount of poison on each head will be about one-seventh of a grain. Considering that fully one half of the powder will fall upon the outside leaves or upon the ground he concludes that a person will have to eat about 28 heads of cabbage in order to consume a poisonous dose of arsenic even if most of the poison remained upon the cabbage after cooking, which of course it does not.

In spite of this encouraging reasoning, however, and in spite of the fact that no cases of poisoning have been reported, although the remedy is in more or less general use, I hesitate to recommend it except while the plants are young. At this time its use is advisable, where necessary, as none of the poison can permanently lodge in the heart or head which is yet unformed.

From the present outlook pyrethrum mixed with water, as above described, or dry mixed with flour, is the safest remedy. Prof. James Fletcher of Canada, a careful and reliable experimenter, says concerning this remedy:

"In the treatment of cabbage caterpillars, pyrethrum diluted with four times its weight of common flour, and then kept tightly closed for

24 hours, leaves nothing to be desired, and thousands of dollars are yearly saved to small growers who most need the assistance." (*Insect Life IV*, 13.)

HARLEQUIN CABBAGE BUG.

(Murgantia histrionica Hahn.)

This I have found to be one of the most destructive insects to cabbages in certain parts of Maryland, and it has been particularly abundant during the last two or three years. Known in the Southern States as the Harlequin Cabbage Bug or the Calico Back, this insect has been gradually spreading from the extreme Southwest to the North and East for the past twenty years, and has only recently become a serious trouble in Maryland. The adult bugs (Figure 15,) hibernate under old grass, stones, logs, and other rubbish, and upon the advent of spring take to the first cruciferous plants that put forth leaf, and lay their little barrel-shaped eggs. (Figure 16 *c*) in small clusters on the undersides of the leaves. There are several generations in the course of the summer and wherever the insect becomes abundant the crop is generally ruined. The insect feeds upon the cabbage in all stages of growth, not by gnawing the leaves, but by puncturing them with its beak, causing the leaves to wilt by exhaustion of the juices.

Fig. 15.—*Murgantia histrionica*, imago with wings closed and with wings expanded.

This is a very difficult insect to deal with, as the older remedies have not proved efficacious. My early recommendations in treating of this insect, of clean culture, raking up and burning all rubbish in autumn and hand-picking the bugs on the first opportunity in spring, were, on the whole, the most available remedies in our possession up to last spring. In 1892, however, Prof. H. E. Weed, of the Mississippi Agricultural Experiment Station, who has had excellent opportunities of studying and experimenting with this insect, because of its great abundance in his locality, found that the following plan was satisfactory, and it may well be adopted by Maryland cabbage growers. Wild Mustard is one of the earliest cruciferous plants to appear in spring, and the hibernated bugs take their first spring meals on this plant. They seem to prefer it, in fact, when young and tender, to cabbage. Mr. Weed at first (1891) killed the bugs upon the mustard whenever he found them, by sprinkling them with pure kerosene, but the following year he decided to sow a row or two of mustard between the prospective rows of cabbages. It resulted from this that the great majority of the hibernated bugs of the vicinity clustered upon these early mustard plants, and were killed by the application of pure kerosene, to the almost perfect protection of the cab-

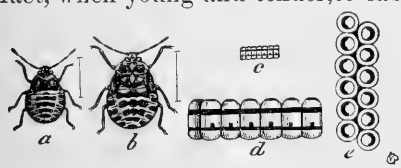


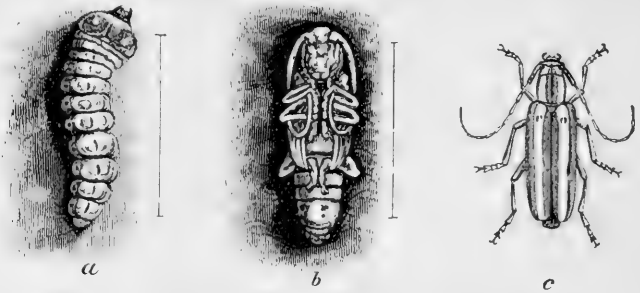
Fig. 16.—*Murgantia histrionica*: *a*, larva *b*, pupa: *c* ♂ eggs: *d* eggs enlarged, side view; *e*, same, top view.

bage crop. I strongly recommend this course as one of the most promising, and where mustard plants are not available or have not been provided, the best remedy to be applied is to spray with a pretty strong kerosene emulsion.

APPLE-TREE BORERS.

There are two borers which seriously effect the apple tree in Maryland, as they do, in fact, in almost all great apple-growing regions in the country east of the Rocky Mountains. These are, the Round-headed Apple-tree Borer (*Saperda candida* L.) and the Flat-headed Borer (*Chrysobothris femorata* F). The former is by far the most frequent and injurious. Both affect the trunk and usually the lower part, but they differ in their mode of work and in their life-habits.

The Round-headed Borer is the larva of a rather handsome long-horned beetle with a number of grayish-white longitudinal stripes (Figure 17 *c*.) The female lays her eggs in the month of June, in the trunks of not only



a *b* *c*

Fig. 17.—*Saperda candida; a*, larva; *b*, pupa; *c*, imago.

the cultivated apple, but of wild crab apple, haw, pear and quince. As I pointed out in 1877 she makes with her jaws an incision in the bark, causing it to split open from one-third to half an inch in length, and thrusts the egg between the bark and the liber at right angles to the side of the slit, accompanying the egg with a gummy fluid which covers it and secures it in place (Fig. 18 *c*). The egg (Fig. 18 *d*,) is pale rust brown in color, elongate ovoid, somewhat flattened and three millimetres long. The young larva hatches in about two weeks and for the first year and a-half of its life lives in the sap wood, excavating shallow cavities, visible only by a slight discoloration of the bark and by a small quantity of sawdust-like castings, which issue from the original hole of entrance or from cracks in the bark. During the third summer it generally commences to cut cylindrical passages up into the wood of the tree, not infrequently perforating it. It then rests in its burrow through the third winter and transforms to pupa (Fig. 17 *b*, 18 *g*,) in the spring, issuing as a beetle during the late spring or early summer.

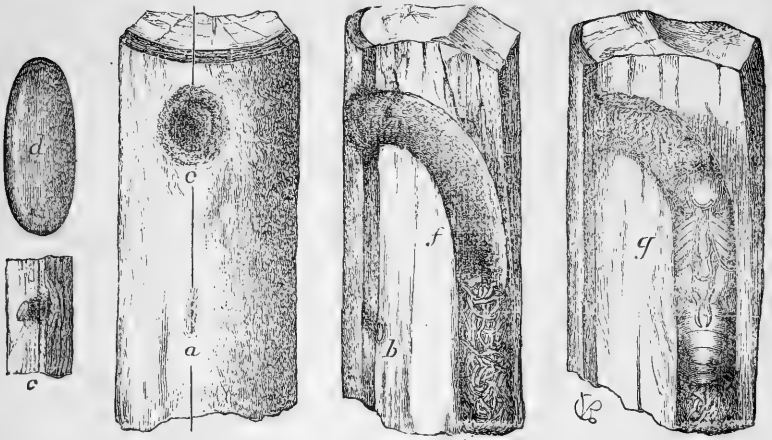


Fig. 18.—*Saperda candida*; *a*, piece of apple branch, showing scar made in oviposition and hole of exit of beetle; *b*, *f*, section of same through line *a*, *c*; *c*, section of bark, showing slit and egg natural size; *d*, egg enlarged; *g*, showing pupa, with packing between it and bark.

This is a summary of its larval habit, based upon the observations of Dr. Asa Fitch, who gave the subject perhaps more close attention than any other previous or subsequent writer. The actual length of the larval life, has, so far as I know, not been proved by any consecutive following of any one individual larva, and there is room here for further experimentation and observation.

This species affects more particularly the base of the tree, and neglected trees, (particularly those where the grass has been allowed to grow up to the base), suffer most.

Fig. 19.—*Chrysobothris femorata*, imago.

The Flat-headed Borer, (*Chrysobothris femorata*,) is the larva of a beetle entirely different in appearance. The shape of this last is indicated in the figure, (Fig. 19), and its color is greenish black, with brassy lines and spots above, instead of being copper color. While the Saperda is essentially nocturnal, this Chrysobothris is diurnal, being found flying about in the hot sunlight. The female lays her eggs under bark scales and in the cracks and crevices of the trunk of many different kinds of trees, including the ash, beech, elm, maple, oak, peach, etc., as well as the apple. The eggs are yellow, irregularly ribbed, and less than a millimetre in length. The larva hatching from this egg, is at once distinguished from that of the Round-headed Borer, by its flattened form and by its broad flattened head, from which feature it derives its popular name, (Fig. 20). It feeds upon the sap wood during most of the summer, and there excavates broad, rather flat channels, a single individual sometimes completely girdling a small tree. Upon approaching full growth it usually eats into the more solid wood and works back to the bark, when ready to transform to the pupa state. The pupa stage lasts about three weeks, when the

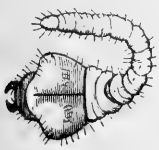


Fig. 20.—*Chrysobothris femorata*, larva.

beetle cuts through the bark and emerges. The burrow made in the solid wood by this insect, is always flattened or elongate-ovoid in shape.

This beetle produces but one annual generation, the larva requiring but one season for full growth. I have known it to become full-grown and to kill young trees, between the first week in June and the last of September, and only the last year had absolute proof of this limitation of the larval life of the insect, by losing a young sycamore tree, which was planted from the nursery as late as the first of June, and which was carefully inspected and showed no evidence of the borer, at the time of planting. This tree was killed by the girdling of the borer by the end of September.

While the Round-headed Borer is found in older trees and frequently in trees that otherwise seem to be vigorous, yet it prefers trees of feeble growth or those which are newly transplanted, and those growing upon ridge lands or in plowed orchards, are more liable to attack, than those growing on low lands or in orchards seeded to grass. With the Flat-headed Borer, however, a great predilection is shown for trees that have been injured in any way, and newly transplanted trees from a nursery should be particularly watched. The injury is most apt to take place on the south-west side, which is most subject to the so-called "sun scald." In fact, it is doubtful if the young larvæ or the eggs can withstand the strong flowing sap of a vigorous tree, and in almost every case in my experience, where this borer has done any damage, it has been as a consequence of some prior injury.

REMEDIAL MEASURES.

A slight discoloration of the tree, a flattening of the bark, a slight exudation of the sap or an extrusion of fresh, sawdust-like excrement or gnawings, will often indicate the presence of these borers, in which case they may frequently be cut out and destroyed, if the work is detected in time, or if they have entered the solid wood, a wire may be used as a probe to follow and kill the borer, or a little hot water or kerosene may be poured into the hole.

Prevention, however, is to be preferred in both cases, and alkaline washes applied to the trunk, have been found by experience to have a deterring effect upon the female beetles and to prevent their laying their eggs upon the trees so treated. I generally take a bar of hard soap and rub it up and down the trunks of young trees, and place a piece in the principal crotch, allowing the rains to gradually wash it down over the trunk. This is a simple preventive method, which Dr. Fitch, many years ago found to be satisfactory, and which I have proved to be so in my own experience. If soft soap is used, the trunk and larger branches may be painted by means of a white-wash brush, the soft soap being reduced to the consistency of thick paint, by the addition of a strong solution of washing soda in water. A certain proportion of either of the arsenical poisons in ordinary use, if mixed with such soap-wash, will serve to render the same more permanent and effective, while a good fish-oil soap

would be preferable to the ordinary soft soap. A good formula is as follows:

Potash lye, 1 pound; fish oil, 3 pints; soft water, 2 gallons. The lye is dissolved in the water, and when brought to the boiling point, the oil is added and the batch is boiled about two hours. Water is filled in to make up the evaporation by boiling, and the result will be about 25 pounds of soap, which will make from 50 to 100 gallons of trunk wash.

INSECTS PARTIALLY STUDIED AT THE STATION,

DURING THE PRESENT YEAR.

Since the first of July Mr. R. S. Lull, one of my assistants, has for the most part made his headquarters at the station, with a view to studying and experimenting on such insects as presented themselves in injurious numbers or attracted particular attention at the station. Most of his investigations are yet incomplete, but the following notes, which are based upon Mr. Lull's observations, are worth recording.

THE TOBACCO FLEA-BEETLE.

This little beetle (*Epitrix parvula* Fab.) did considerable damage to the tobacco plants grown at the station by eating small holes in the leaves, giving them an unsightly appearance. Anything affecting the appearance of the leaf of tobacco naturally reduces materially its value as a crop. The beetle is yellowish-brown in color and but 1.5 millimetres (about .06 of an inch) in length. It is one of the few insects of economic importance the life-history of which has not been followed out, but this I hope to do in the near future. In the meanwhile, without knowing anything of the habits of the larva, it will be difficult to protect the tobacco crop from its injuries, since the ordinary poisonous insecticides must not be used. Mr. Lull found that pyrethrum in powder, diluted with flour or road dust destroyed a large proportion of those beetles which it touched, but the trouble is, as in the case of the Rose Chafer and a number of other insects, other individuals quickly take the place of those which are killed, and some other preventive must be found with which to check the injuries of this particular species.

THE TOBACCO SPHINX, OR HORN WORM.

This well known insect (*Protoparce celeus* Hbn.) was also quite abundant in the tobacco fields at the station, and did considerable damage, as it generally does in all parts of the country to the tomato. The life-history of this species is well known, and there is nothing new to be ascertained in reference to it. The eggs are about the size of a pin-head, green in color, and laid singly on the undersides of the leaves. The larva develops rapidly, is an enormous feeder, and late in the summer descends into the ground, where it transforms to the pupa state, in which it remains through the winter. Hand-picking is chiefly resorted to, especially in tobacco fields, to keep this species in check, and a more rapid way of working is to go through the field with a pair of shears and clip each worm in two as fast as detected. Those which bear on their backs or

bodies clusters of white, oval, egg-like cocoons should be left alone, as the cocoons are those of the Microgaster parasite, which should be given every opportunity to multiply. Late fall ploughing results in the destruction of many of the pupæ, and a large number of the parent moths may be poisoned by pouring a little liquid cobalt into the flowers of the "Jimpson" weed (*Datura stramonium*) The moths are strongly attracted to the flowers, and readily suck up the poisonous dose. This method has been so effective at the Louisiana Station that a row of Jamestown weeds has been purposely planted around the tobacco field, while a patent has been granted for an imitation of the Jamestown weed flower in porcelain, to be used for the same purpose.

THE MELON PLANT-LOUSE.

This insect (*Aphis cucumeris* Forbes) was observed in great numbers on the undersides of the leaves of the canteloupe vines during the latter part of July. No new observations of any importance were made, but it was noticed that, contrary to the ordinary published statements, the lice remained quite numerous beyond the time of ripening of the fruit, a winged brood appearing during the first week in August. Under-spraying of the leaves with a dilute kerosene emulsion is recommended for this insect, and the spraying is done by fitting to the hose of a knapsack or bucket pump an upturned Cyclone nozzle, the hose being clamped or wired to a three-foot cane, so that the nozzle may be readily thrust beneath the leaves. This is probably the most convenient method where a large number of vines have to be treated. Mr. H. Garman, of the Kentucky Experiment Station, uses bisulphide of carbon in a very effective way against this insect, and his method is advisable for smaller patches. One entire vine is well gathered up into a bunch and a large sized wash-tub is inverted over it. A table spoonful of bisulphide of carbon in a saucer is then placed under the tub and the edge of the latter is pressed down into the earth. The bisulphide evaporates rapidly and its fumes kill the lice without injury to the plant.

THE ASPARAGUS BEETLE.

This is a handsome black, yellow and red beetle, known by the scientific name of *Crioceris asparagi*, L. It is a well-known species, passes the winter in the beetle state, and lays small, black, ovoid eggs on the young asparagus shoots in spring. The larvæ hatching from these eggs reach full growth in about two weeks and descend into the ground to undergo transformation into pupæ and beetles. The second generation of beetles appear ten days after the descent into the earth, and lay their eggs for a second generation of larvæ on the more mature plants. The actual number of generations during the year has not been definitely ascertained and we may assume that it will vary according to the latitude. There is in Maryland, without much doubt, a third generation of beetles which go into winter quarters rather early. The fact that Mr. Lull found eggs, larvæ and beetles rather abundant on old asparagus plants as late as August 31, would indicate that there may be even four generations in this latitude.

This insect has long been quite destructive in the vicinity of Baltimore and Washington, and yet it is not difficult to handle. A very light dusting of pyrethrum powder mixed with spoiled flour in the proportion of one to ten, is the cleanest and best way to treat the first larvæ observed, and even without insecticide substances, the daily cutting off of all shoots upon which eggs are observed will serve to effectively check the work of the first brood. As it is the neglected later broods which rapidly multiply after the market season is over, which supply the hibernating beetles that damage the young shoots the following spring, it is quite important to treat these later broods. All voluntary asparagus in the neighborhood of the beds should be rooted up and destroyed and only a few plants should be allowed to grow. These will attract the beetles that are in the immediate neighborhood, and their larvæ may be killed in the manner already indidicated or by the use of kerosene emulsion, which, if repeated two or three times during July and August will serve materially to prevent injury the following spring.

BLISTER BEETLES.

The Striped Blister-beetle (*Epicauta vittata* F.) and the Black Blister-beetle (*E. pennsylvanica* DeG.) were very abundant the latter part of the season, the former feeding upon potato plants in early August and upon beets in early September, and the latter upon carrots in September. A little later a number of complaints were received of damage to chrysanthemums by the black species. The abundance of these insects may, to a certain extent, be traced to the abundance of locusts or grasshoppers the previous year, since in their larval state both these species are partially parasitic in the egg masses of these locusts. During the present year these locusts have been extremely abundant, and there is therefore every reason to expect large numbers of the blister beetles towards the close of next summer. The experiments which Mr. Lull made with the arsenical sprays were remarkable successful. On August 5th he sprayed a potato patch infested with the Striped Blister Beetle pretty thoroughly with Paris green, it being well known that the foliage of the potato plant will stand without injury London purple or Paris green in the proportion of one pound of the poison to 75 gallons of water. The carrot patch was similarly sprayed for the black species. The beetles rapidly disappeared from the plants thus treated. In regions where the beetles make earlier inroads into the fields, experience has not been so satisfactory with the arsenical sprays. This is due to the fact that the poisoned beetles fly away and die, and their places are taken by later-issuing individuals, thus neutralizing the treatment. In the extensive beet fields of the west it is the custom, when these insects are abundant, to send men or boys through the field, working with the wind, and driving the beetles before them by short flights. On the leeward side of the field windrows of hay or straw have been previously placed, and into these the beetles are driven and then burned. This is an old remedy that has been successfully used in large potato fields. The damage done to chrysanthemums, and especially to

Fig. 21.—*Epicauta vittata*, imago.

clematis vines, by these insects, is often quite serious, and there is no perfectly satisfactory way of protecting these plants under such circumstances, other than by covering them with gauze or netting.

The following is a condensed account of the very peculiar life-history of the Striped Blister-beetle which may be taken as a type of the life-histories of the other blister-beetles here mentioned. Those who are interested in the subject will find full details in a paper in the Transactions of the Academy of Sciences of St. Louis, volume III., and in the First Report of the U. S. Entomological Commission, pages 293-301.

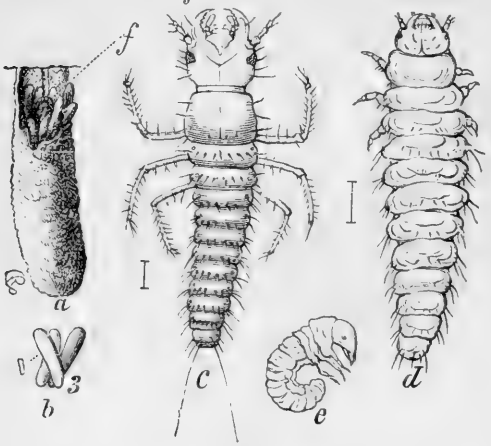


Fig. 22.—*Epicauta vittata*; *a*, egg-pod of *Caloptenus differentialis* with the mouth torn open, exposing the newly hatched larva of Epicauta eating into an egg; *b*, egg; *c*, first larva, or triungulin (greatly enlarged); *d*, caraboid stage of second larva; dorsal view (greatly enlarged).

From July to the middle of October the female lays her eggs in the ground in loose, irregular masses of about 130, on the average. Each female lays from 400 to 500 eggs, choosing locations which are apt to be used for the same purpose by locusts. In about ten days the eggs hatch and the first larva, known as the triungulin, emerges (Fig. 22, *c*.) This little larva is at first feeble and perfectly white, but soon turns brown and becomes very active when warmed by the sun, running about over the surface of the ground and searching for egg pods. When one of these is found, the triungulin bores through the neck of the pod and begins to eat it away (Fig. 22, *a*.) After absorbing the substance of one or two eggs, this triungulin moults and produces the second larva, known as the carabæoid stage (Fig. 22, *d*). In this stage it lies in a curved position within the pod, as shown at *e*. During the growth of the larva, which is rapid, several other moults take place, the second one producing the scarabæoid stage (Fig. 23, *a*) in which the larva looks very much like an ordinary white grub. A third moult results in little change structurally, but the larva attains full size, and generally leaves the egg pod which it has by this time gutted. After the fourth moult, a still greater change takes place and the larva becomes shrunken, rigid and hardened, with the legs and mouth-parts reduced to mere tubercles. This is known as the coarctate lar-

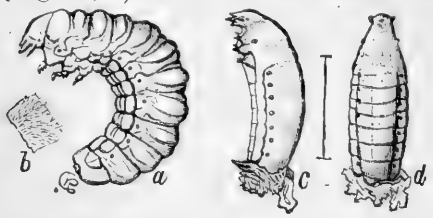


Fig. 23.—*Epicauta vittata*; *a*, full grown stage of second larva; *b*, portion of the dorsal skin of same; *c*, pseudo-pupa, or coarctate larva, lateral view; *d*, same, dorsal view.

val stage (Fig. 23, *c. d.*) The fifth moult causes this hardened shell to split open and from it there issues the ultimate larva, which resembles the scaraboid stage in appearance, except that the larva is more active and moves about–without feeding, however. It burrows a short distance into the soil, where it forms a cavity within which, in the course of a few days, it transforms with the sixth moult to the true pupa, (Fig. 24.) It is in the coarctate larva stage that the insect generally passes the winter, the true pupa state being assumed only in early summer just before the perfect beetles issue from the ground.

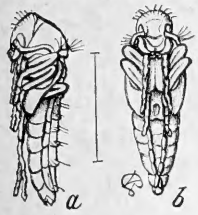


Fig. 24.—*Epicauta vittata; a*, true pupa, side view; *b*, same, ventral view.

These curious larval changes are designated as hypermetamorphoses by entomologists, and it will be seen from the figures and from the brief descriptions, that with each moult until the coarctate larval stage is assumed, there is a rapid reduction in the size of the legs and mouth-parts, and the animal becomes more and more helpless. The habit of feeding on locust or grasshopper eggs to a certain degree offsets the destructive habits of the perfect beetles.

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